

# Spacecraft Technology Developments 1949-2002

## Electronic Intelligence

- Galactic Radiation and Background (GRAB) Experiment — 1<sup>st</sup> Reconnaissance Satellite

## Satellite Tracking/Telemetry

- Minitrack
- Naval Space Surveillance Fence
- Blossom Point, MD Facility

## Precision Clocks/Time Transfer/Navigation

- Timation Series — 1<sup>st</sup> time-transfer spacecraft; 1<sup>st</sup> Ultrastable Crystal Clock; NTS-I 1<sup>st</sup> Rubidium Clock
- NTS-II — 1<sup>st</sup> in GPS constellation; NRL holds patent; 1<sup>st</sup> Cesium Beam Clock; Hydrogen Maser Clock

## Batteries

- NTS-II or GPS 1 — 1<sup>st</sup> Independent Pressure Vessel flown
- Titan Launch Dispenser — 1<sup>st</sup> Nickel Hydrogen flown
- Clementine — 1<sup>st</sup> Common Pressure Vessel (NiH<sub>2</sub>) flown
- Shuttle — 1<sup>st</sup> Sodium Sulphur flown

## Onboard Processor/Software

- R3000 — 1<sup>st</sup> on Clementine
- COMET and Satellite Control Language

## Attitude Control/Determination

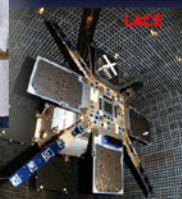
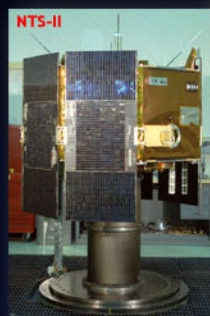
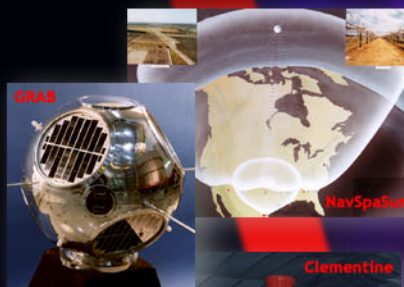
- GGSE-1 — 1<sup>st</sup> gravity gradient stabilized spacecraft
- GGSE-3 — 1<sup>st</sup> 3-axis spin gravity gradient stabilized spacecraft
- Clementine — 1<sup>st</sup> fully autonomous spacecraft
- 1<sup>st</sup> Attitude Determination Using GPS and Smart Structures

## Tether Systems and Antenna/Mast Technology

- TIPS — Longest lasting spacecraft tether system
- LOFTI — 1<sup>st</sup> metal ribbon antenna that extends and retracts
- LACE — 1<sup>st</sup> 150-ft mast that is deployable and retractable

## Rocket Plume Shield

- Living Plume Shield (LiPS) Satellite developed by using the normally discarded rocket plume shield as a spacecraft that carried tactical communications



## Advanced Release Technologies

- Frangibolts
- Laser Initiated Ordnance
- Fast Acting Separation Release Nut
- Non-Explosive Separation Nut

## Rockets/Propulsion

- Viking Rockets — NRL directed development of eleven vehicles
- Vanguard Rocket — 1<sup>st</sup> 3-stage rocket
- Solrad-8 — 1<sup>st</sup> use of gas thrusters
- GGSE-3 — 1<sup>st</sup> use of microthrusters
- Titan Launch Dispenser
- Hall Effect Thrusters

## Solar Cells

- Vanguard — 1<sup>st</sup> spacecraft to be powered by solar cells
- Living Plume Shield (LiPS) — 1<sup>st</sup> use of Triple Junction cells